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USACE / NAVFAC / AFCEA UFGS-L-15700N (January 2004)  
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Preparing Activity: LANTNAVFACENGCOM Superseding  
UFGS-L-15700N (January 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

Use for LANTNAVFACENGCOM projects only

Latest changes indicated by CHG tags

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SECTION 15700N

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01/04

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SECTION 15700N

HEATING, VENTILATING, AND COOLING SYSTEM  
01/04

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NOTE: This guide specification covers the requirements for heating, ventilating, and cooling (HVAC) systems including equipment, ducts, and piping which is located within, on, under, and adjacent to buildings.

Systems include cooling equipment less than 211 KW 720,000 Btuh, and heating equipment less than 117 KW 400,000 Btuh.

Use the most efficient competitively available equipment for which there are at least two products available for the indicated ranges of comparability.

System requirements must conform to NAVFAC MIL-HDBK-1003/3, "Heating, Ventilating, Air Conditioning, and Dehumidifying Systems."

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NOTE: The following information shall be shown on the projects drawings:

1. Operating requirements for each item of equipment shall be indicated on the drawings including capacity, efficiency, sound ratings, motor speeds, electrical characteristics, and special features.

2. Design HVAC systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement). Indicate the equipment operating requirements, including efficiency, on the drawings.

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NOTE: Suggestions for improvement of this specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under "Forms/Documents" directory or DD Form 1426. Suggestions should be forwarded to:

Atlantic Division  
Naval Facilities Engineering Command  
Attention EICO  
1510 Gilbert Street  
Norfolk, VA 23511-2699

FAX: (757) 322-4416 or DSN 262-4416

Email: LantDiv@efdlant.navfac.navy.mil

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

#### ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

AHAM DCRAC (1999) Directory of Certified Room Air Conditioners

AHAM RAC-1 (1992) Room Air Conditioners

#### AIR MOVEMENT AND CONTROL ASSOCIATION, INC. (AMCA)

AMCA 210 (1990) Testing Fans for Rating

AMCA 500 (1991) Louvers, Dampers and Shutters

AMCA 511 (1991) Certified Ratings Program for Air Control Devices

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22 (1999) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

#### AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI APD	(1996) Applied Products Directory
ARI UD	(1996) Unitary Directory
ARI 210/240	(1994) Unitary Air-Conditioning and Air-Source Heat Pump Equipment
ARI 310	(1990) Packaged Terminal Air-Conditioners
ARI 340/360	(1993) Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment
ARI 365	(1994) Commercial and Industrial Unitary Air-Conditioning Condensing Units
ARI 380	(1990) Packaged Terminal Heat Pumps
ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1989) Central-Station Air-Handling Units
ARI 440	(1998) Room Fan-Coil and Unit Ventilator
ARI 550/590	(1998; Addendum 1999) Water-Chilling Packages Using the Vapor Compression Cycle
ARI 710	(1986) Liquid-Line Driers
ARI 880	(1998) Air Terminals

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING  
ENGINEERS, INC. (ASHRAE)

ASHRAE 15	(1994; Errata 1994) Safety Code for Mechanical Refrigeration
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AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(1998) Malleable Iron Threaded Fittings Classes 150 and 300
ASME B16.5	(1996; Addenda 1998) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(1984; R 1994, R 1996) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV

ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(1996; Addenda 1998) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.5	(1992; Addenda 1994) Refrigeration Piping
ASME B31.9	(1996) Building Services Piping
ASME BPVC	(2000) Boiler and Pressure Vessel Codes

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(1993; Errata 1993) Water Pressure Reducing Valves
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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A53/A53M	(1999; Rev. B) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A106	(1999) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A193/A193M	(2000) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	(2000; Rev. A) Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A653/A653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B32	(2000) Solder Metal
ASTM B42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B88M	(1999) Seamless Copper Water Tube (Metric)
ASTM B88	(1999) Seamless Copper Water Tube
ASTM B280	(1999) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B306	(1999) Copper Drainage Tube (DWV)

ASTM C1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM F441/F441M	(1999) Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Schedules 40 and 80
ETL TESTING LABORATORIES (ETL)	
ETL DLP	(2000) Directory of ETL Listed Products
FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)	
FCCCHR-USC	(2001) List of Approved Backflow Prevention Assemblies
GAS APPLIANCE MANUFACTURERS ASSOCIATION (GAMA)	
GAMA CDCER	(1996) Consumer's Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS)	
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves Flanged and Threaded Ends
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA ICS 6	(1993; Rev. 1-4) Industrial Control and Systems Enclosures
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 31	(2001) Installation of Oil Burning Equipment
NFPA 70	(2002) National Electrical Code
NFPA 90A	(1999) Installation of Air Conditioning



## and Ventilating Systems

NFPA 96 (1998) Ventilation Control and Fire Protection of Commercial Cooking Equipment

### NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RWM (1996) Roofing and Waterproofing Manual

### SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC. (SMACNA)

SMACNA HVACMF (1995; Addendum 1997) HVAC Duct Construction Standards - Metal and Flexible

SMACNA HVACTAB (1993) HVAC Systems Testing, Adjusting and Balancing

SMACNA HVACTM (1985) HVAC Air Duct Leakage Test Manual

### UNDERWRITERS LABORATORIES INC. (UL)

UL BMD (1999) Building Materials Directory

UL EAUED (2000) Electrical Appliance and Utilization Equipment Directory

UL 142 (1993; R 1998, Bul. 1999 and 2000) Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 181 (1996; Bul. 1996 and 1998) Factory-Made Air Ducts and Air Connectors

UL 296 (1994; R 1998, Bul. 2000) Oil Burners

UL 507 (1999; Bul. 1999 and 2000 ) Electric Fans

UL 555 (1999; R. 2000, Bul. 1999 and 2000) Fire Dampers

UL 726 (1995; R. 1999, Bul. 2000) Oil-Fired Boiler Assemblies

UL 1316 (1994; R 1996, Bul. 1997, 1998, 1999, and 2000) Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures

## 1.2 SYSTEM DESCRIPTION

Provide [new][ and modify existing] heating, ventilating, and cooling (HVAC) systems complete and ready for operation. HVAC systems include equipment, ducts, and piping which is located within, on, under, and adjacent to buildings.

## 1.3 SUBMITTALS

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NOTE: Where a "G" in submittal tags follows a  
submittal item, it indicates Government approval for  
that item. Add "G" in submittal tags following any  
added or existing submittal items deemed  
sufficiently critical, complex, or aesthetically  
significant to merit approval by the Government.  
Submittal items not designated with a "G" will be  
approved by the QC organization.  
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Submit the following in accordance with Section 01330, "Submittal  
Procedures."

SD-03 Product Data

Product data for integral or appurtenant space temperature  
controls (STC) supplied with the listed equipment shall include  
shall include point-to-point electrical wiring diagrams for each  
STC.

Packaged air-conditioners,including STC data; G

Split-system air-conditioners,including STC data; G

Packaged heat pumps,including STC data; G

Split-system heat pumps,including STC data; G

Packaged air-handling units,including STC data; G

Multizone air-handling units; G

Air-cooled water chillers; G

Air-cooled condensing units; G

Room fan-coil air-conditioners,including STC data; G

Room air-conditioners,including STC data; G

Packaged terminal air-conditioners,including STC data; G

Packaged terminal heat pumps,including STC data; G

Series fan powered variable air volume (VAV) terminals; G

Liquid cooling radiators

Cabinet unit heaters,including STC data

Unit heaters

Convectors

Finned tube radiation

Hot water converters

Oil-fired heating boilers and underground fuel oil storage tank G  
Pumps, including performance curves for each impeller size; G  
Exhaust fans  
Direct vent gas-fired central furnaces, including STC data; G  
Ceiling hugger type fans  
Sound-Attenuator Ducts  
Diffusers, registers, and grilles; G  
Outside air intake louvers  
Fire dampers  
Duct heaters; G  
Linear Diffusers; G  
Specialty Valves; G  
Dielectric Connections  
Expansion tanks  
Air separators  
Heat tape

#### SD-06 Test Reports

Piping welds NDE report

[Packaged air-conditioners - field acceptance test plan; equipment greater than 52,700 W 180,000 Btuh.; G]

[Split-system air-conditioners - field acceptance test plan; equipment greater than 52,700 W 180,000 Btuh.; G]

[Packaged heat pumps - field acceptance test plan; equipment greater than 17,600 W 60,000 Btuh.; G]

[Split-system heat pumps - field acceptance test plan; equipment greater than 17,600 W 60,000 Btuh.; G]

[Packaged air-handling units - field acceptance test plan; equipment greater than 944 L/S 2,000 cfm.; G]

[Multi-zone air-handling units - field acceptance test plan; equipment greater than 944 L/S 2,000 cfm.; G]

[Air-cooled water chillers - field acceptance test plan; equipment greater than 52,700 W 180,000 Btuh.; G]

[Variable air volume (VAV) terminals - field acceptance test plan; including plan for related air handling unit.; G]

[Air-cooled condensing units - field acceptance test plan;  
equipment greater than 52,700 W 180,00 Btuh.; G]

[Packaged air-conditioners - field acceptance test report;  
equipment greater than 52,700 W 180,000 Btuh.; G]

[Split-system air-conditioners - field acceptance test report;  
equipment greater than 52,700 W 180,000 Btuh.; G]

[Packaged heat pumps - field acceptance test report; equipment  
greater than 17,600 W 60,000 Btuh.; G]

[Split-system heat pumps - field acceptance test report; equipment  
greater than 17,600 W 60,000 Btuh.; G]

[Packaged air-handling units - field acceptance test report;  
equipment greater than 944 L/S 2,000 cfm.; G]

[Multi-zone air-handling units - field acceptance test report;  
equipment greater than 944 L/S 2,000 cfm.; G]

[Air-cooled water chillers - field acceptance test report;  
equipment greater than 52,700 W 180,000 Btuh.; G]

[Variable air volume (VAV) terminals - field acceptance test report;  
including plan for related air handling unit.; G]

[Air-cooled condensing units - field acceptance test report;  
equipment greater than 52,700 W 180,00 Btuh.; G]

#### SD-07 Certificates

Employer's record documents

Welding procedures and qualifications

#### SD-08 Manufacturer's Instructions

[Packaged air-conditioners - installation instructions]

[Split-system air-conditioners - installation instructions]

[Packaged heat pumps - installation instructions]

[Split-system heat pumps - installation instructions]

[Packaged air-handling units - installation instructions]

[Multizone air-handling units - installation instructions]

[Air-cooled water chillers - installation instructions]

[Air-cooled condensing units - installation instructions]

[Room fan-coil air-conditioners - installation instructions]

[Room air-conditioners - installation instructions]

[Packaged terminal air-conditioners - installation instructions]

[Packaged terminal heat pumps - installation instructions]

[Series fan powered variable air volume (VAV) terminals - installation instructions; submit with respective air-handling unit.]

[Liquid cooling radiators - installation instructions]

[Unit heaters - installation instructions]

[Oil-fired heating boilers - installation instructions and underground fuel oil storage tank - installation instructions]

[Pumps - installation instructions]

[Exhaust fans - installation instructions]

[Direct vent gas-fired central furnaces - installation instructions]

[Fire dampers - installation instructions]

#### SD-10 Operation and Maintenance Data

Submit in accordance with Section 01781N, "Operation and Maintenance Data."

Packaged air-conditioners, Data Package 3 G

Split-system air-conditioners, Data Package 3 G

Packaged heat pumps, Data Package 3 G

Split-system heat pumps, Data Package 3 G

Packaged air-handling units, Data Package 3 G

Multizone air-handling units, Data Package 3 G

Air-cooled water chillers, Data Package 3 G

Air-cooled condensing units, Data Package 3 G

Room fan-coil air-conditioners, Data Package 2 G

Room air-conditioners, Data Package 2 G

Packaged terminal air-conditioners, Data Package 2 G

Packaged terminal heat pumps, Data Package 2 G

Series fan powered variable air volume (VAV) terminals, Data Package 3. Submit with respective air-handling unit. G

Liquid cooling radiators, Data Package 2 G

Unit heaters, Data Package 2 G

Oil-fired heating boilers and underground fuel oil storage tank,  
Data Package 3 G

Pumps, Data Package 2 G

Exhaust fans, Data Package 2 G

Direct vent gas-fired central furnaces, Data Package 3

Fire dampers, Data Package 1 G

#### 1.4 QUALITY ASSURANCE

##### 1.4.1 Welding Requirements

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

##### 1.4.1.1 Employer's Record Documents

Submit to the ROICC for his review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

- a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.
- b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.
- c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

##### 1.4.1.2 Welding Procedures and Qualifications

- a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.
- b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the

qualification tests.

#### 1.4.1.3 Welding Examinations

Conduct non-destructive examinations (NDE) on piping welds and verify welds meet the acceptance criteria specified in ASME B31.9. NDE on piping welds covered by ASME B31.9 is visual inspection only. Submit a piping welds NDE report meeting the requirements specified in ASME B31.9.

### PART 2 PRODUCTS

Provide HVAC system including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASME B31.5, ASME B31.9, [and NFPA 70,] as modified and supplemented by the contract specifications and drawings.

#### 2.1 EQUIPMENT

Equipment using refrigerants R-11, R-12, R-113, R-114, R-115, R-500, or refrigerants with ozone depletion factor (ODF) greater than 0.05 shall not be permitted.

##### 2.1.1 Packaged Air-Conditioners

\*\*\*\*\*  
NOTE: Design air conditioning systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement). Indicate the equipment operating requirements, including efficiency, on the drawings.  
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NOTE: A 20 ton rated air conditioner located on the facility roof should be mounted on its own structural steel skid which in turn is supported by spring isolators from structural roof framing. Designers should determine from equipment manufacturers the most practicable method of mounting the equipment on the roof and indicate the configuration on the design drawings.  
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Provide single package unit factory assembled, designed, tested, and rated in accordance with ARI 210/240 or ARI 340/360 for cooling. Unit shall be ARI certified or rated in ARI UD for cooling. Provide guards to protect condenser fins. Unit shall be listed in UL EAUED or ETL DLP.

- a. Filter section: Provide UL listed, [25] [51] mm [1] [2] inch thick 30 percent efficient throwaway fiberglass filters, standard dust-holding capacity, 1.8 m/s 350 fpm maximum face velocity.
- b. Safety controls: Provide low refrigerant pressure protection and pressure relief device. Provide compressor motor with thermal and overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide compressor with electrical crankcase heater and internal high pressure protection. The above safety controls are not required when scroll compressors are provided.

- c. Heating section: [Provide ARI 410 hot water coils or non-freeze double tube steam coils as indicated.] [Provide UL or ETL listed electric resistance heaters including internal fusing integral with heaters; fan shall run until heater cools.]
- d. Space temperature controls: [Provide digital electronic controls including adjustable programmable thermostats with COOL-OFF-HEAT system switch and AUTO-ON fan switch. Thermostats shall be provided by unit manufacturer. Provide relays, transformers, contactors, and control wiring between thermostats and unit.] [Provide controls under Section 15901N, "Space Temperature Control Systems."] [Provide controls under Section 15910N, "Direct Digital Control Systems."]
- e. Weatherproof casing: Provide removable gasketed panels designed to exclude driving rain for access to fans, coils, filters, compressors, motors, and controls. Provide weatherproof outside air intake louvers or weatherproof hoods with moisture eliminators.
- f. Roof curbs: Provide factory-fabricated galvanized steel roof curbs, wood nailers, insulation, and seal strips in accordance with NRCA RWM curb detail for rooftop air-handling units. Roof curbs shall be furnished by unit manufacturer.
- [g. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.2 Split-System Air-Conditioners

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**NOTE: Design air conditioning systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).**  
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**NOTE: In compliance with FEMP/Energy Star requirements, units rated 19040 W 65,000 Btuh (5.4 tons) and below for cooling shall have minimum SEER of 12; larger units have other requirements. Indicate the equipment operating requirements, including efficiency, on the drawings.**  
  
**Modify this paragraph as required when direct vent gas-fired central furnaces are provided with split-system air-conditioners.**  
 \*\*\*\*\*

Provide units factory assembled, designed, tested, and rated in accordance with ARI 210/240 or ARI 340/360 for cooling. Provide separate assemblies designed to be used together. Base ratings on the use of matched assemblies. Units shall have a minimum SEER as specified on the drawings when tested in accordance with ARI 210/240 or ARI 340/360 as applicable. Units shall be ARI certified or rated in ARI UD for cooling. Outside unit shall include compressor and condenser. Provide guards to protect condenser fins. Units shall be listed in UL EAUED or ETL DLP.



- a. Filter section: Provide UL listed, [25] [51] mm [1] [2] inch thick 30 percent efficient throwaway fiberglass filters, standard dust-holding capacity, 1.8 m/s 350 fpm fiberglass filters, maximum face velocity. [Provide [60] [70] [80] percent efficient bag final filters, 1.8 m/s 350 fpm maximum face velocity.] [Provide gasketed hinged access panel with quick opening half-twist latches at end of filter rack.]
- b. Safety controls: Provide low refrigerant pressure protection and pressure relief device. Provide compressor motor with thermal and overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide compressor with electrical crankcase heater and internal high pressure protection. The above safety controls are not required when scroll compressors are provided.
- c. Heating section: [Provide ARI 410 hot water coil or non-freeze double tube steam coil as indicated.] [Provide UL or ETL listed electric resistance heaters including internal fusing integral with heaters; fan shall run until heater cools.]
- d. Space temperature controls: [Provide digital electronic controls including adjustable programmable thermostats with COOL-OFF-HEAT system switch and AUTO-ON fan switch. Thermostats shall be provided by unit manufacturer. Provide relays, transformers, contactors, and control wiring between thermostats and unit.] [Provide controls under Section 15901N, "Space Temperature Control Systems."] [Provide controls under Section 15910N, "Direct Digital Control Systems."]
- [e. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

### 2.1.3 Packaged Heat Pumps

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**NOTE: Design heat pump systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).**  
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**NOTE: In compliance with FEMP/Energy Star requirements, units rated below 19040 W 65,000 Btuh (5.4 tons) cooling powered by single phase current shall have minimum SEER of 12, minimum HSPF of 7.7, and a minimum combined SEER plus HSPF of 19.7; larger units have other requirements. Indicate the equipment operating requirements, including efficiency, on the drawings.**  
 \*\*\*\*\*

Provide single package unit factory assembled, designed, tested, and rated in accordance with ARI 210/240 or ARI 340/360. Unit shall be ARI certified or rated in ARI UD. Provide guards to protect condenser fins. Unit shall be listed in UL EAUED or ETL DLP.

- a. Filter section: Provide UL listed throwaway 25 mm one inch thick fiberglass filters, standard dust-holding capacity, 1.8 m/s 350 fpm maximum face velocity. [Provide gasketed hinged access panel

with quick opening half-twist latches at end of filter rack.  
Filter rack shall accept 51 mm 2 inch thick filters.]

- b. Safety controls: Provide low refrigerant pressure protection and pressure relief device. Provide compressor motor with thermal and overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide compressor with electrical crankcase heater and internal high pressure protection. The above safety controls are not required when scroll compressors are provided.
- c. Supplemental heater section: Provide UL or ETL listed electric resistance heaters including internal fusing integral with unit; fan shall run until heater cools. Locate downstream of coils. Provide controls to operate heaters only when indoor thermostat is in heating mode and outdoor thermostat indicates outside temperature is below 1.7 degrees C 35 degrees F or unit balance point, whichever is higher; and when unit is in defrost mode at any outside temperature.
- d. Space temperature controls: [Provide digital electronic controls including adjustable programmable thermostats with COOL-OFF-HEAT system switch and AUTO-ON fan switch. Thermostats shall be provided by unit manufacturer. Provide relays, transformers, contactors, and control wiring between thermostats and unit.] [Provide controls under Section 15901N, "Space Temperature Control Systems."] [Provide controls under Section 15910N, Direct Digital Control Systems.]
- e. Weatherproof casing: Provide removable gasketed panels designed to exclude driving rain for access to fans, coils, filters, compressors, motors, and controls. Provide weatherproof outside air intake louvers or weatherproof hoods with moisture eliminators.
- f. Roof curbs: Provide factory-fabricated galvanized steel roof curbs, wood nailers, insulation, and seal strips in accordance with NRCA RWM curb detail for rooftop air-handling units. Roof curbs shall be furnished by unit manufacturer.
- [g. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.4 Split-System Heat Pumps

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NOTE: Design heat pump systems for energy efficiency  
in compliance with FEMP/Energy Star requirements  
specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).  
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\*\*\*\*\*  
NOTE: In compliance with FEMP/Energy Star  
requirements, units rated below 65,000 Btuh (5.4  
tons) cooling powered by single phase current shall  
have minimum SEER of 12, minimum HSPF of 7.7, and a  
minimum combined SEER plus HSPF of 19.7; larger  
units have other requirements. Indicate the  
equipment operating requirements, including  
efficiency, on the drawings..  
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Provide units factory assembled, designed, tested, and rated in accordance with ARI 210/240 or ARI 340/360. Units shall be ARI certified or rated in ARI UD in lieu of listing in the ARI Directory, a letter of certification from ARI that the units have been certified and will be listed in the next Directory will be acceptable. Outside unit shall include compressor and condenser. Units shall include casing, centrifugal fan and motor, primary VAV damper or valve, solid state speed controller or discharge air damper, primary air inlet cone with high and low pressure flow sensors, recirculating air filter frames, filter, and electrical disconnect.

- a. Filter section: Provide UL listed throwaway one 25 mm one inch fiberglass filters, standard dust-holding capacity, 1.8 m/s 350 fpm maximum face velocity. [Provide gasketed hinged access panel with quick opening half-twist latches at end of filter rack. Filter rack shall accept 51 mm 2 inch thick filters.]
- b. Safety controls: Provide low refrigerant pressure protection and pressure relief device. Provide compressor motor with thermal and overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide compressor with electrical crankcase heater and internal high pressure protection. The above safety controls are not required when scroll compressors are provided.
- c. Supplemental heater section: Provide UL or ETL listed electric resistance heaters including internal fusing integral with indoor unit; fan shall run until heater cools. Locate downstream of indoor coil. Provide controls to operate heater only when indoor thermostat is in heating mode and outdoor thermostat indicates outside temperature is below 1.7 degrees C 35 degrees F or unit balance point, whichever is higher; and when unit is in defrost mode at any outside temperature.
- d. Space temperature controls: [Provide digital electronic controls including adjustable programmable thermostats with COOL-OFF-HEAT system switch and AUTO-ON fan switch. Thermostats shall be provided by unit manufacturer. Provide relays, transformers, contactors, and control wiring between thermostats and unit.] Provide an indicator light on the room thermostat which shall indicate when supplementary heaters are operating. [Provide controls under Section 15901N, "Space Temperature Control Systems."] [Provide controls under Section 15910N, "Direct Digital Control Systems."]
- e. Air Coils: Extended-surface fin and tube type with seamless copper or aluminum tubes with copper or aluminum fins securely bonded to the tubes. On coils with all-aluminum construction, provide tubes of aluminum alloy 1100, 1200, or 3102; provide fins of aluminum alloy 7072; and provide tube sheets of aluminum alloy 7072 or 5052. [Provide a coating on [outdoor air] [and] [indoor air] coils as specified in the paragraph entitled, "Coatings for Finned Tube Coils." Coils to be coated shall be part of manufacturer's standard product for capacities and ratings indicated and specified. Provide plate type fins.]
- f. Compressors: For compressors above 70.32 KW 20 tons, compressor speed shall not exceed 3450 rpm. For equipment over 35.16 KW 10 tons, provide automatic capacity reduction for at least 50 percent

of rated capacity. Capacity reduction may be accomplished by cylinder unloading, use of multiple, but not more than four compressors, or a combination of the two methods. Units with cylinder unloading shall start with capacity reduction devices in the unloaded position. Units with multiple compressors shall have a means to sequence starting of compressors. Provide compressors with devices to prevent short cycling when shutdown by safety controls. Provide reciprocating compressors with crankcase heaters, and vibration isolators.

[g. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.5 Packaged Air-Handling Units

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**NOTE: A 20 ton rated air-handling unit located on the facility roof should be mounted on its own structural steel skid which in turn is supported by spring isolators from structural roof framing. Designers should determine from equipment manufacturers the most practicable method of mounting the equipment on the roof and indicate the configuration on the design drawings.**

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Provide units factory assembled, designed, tested, and rated in accordance with ARI 430. Units shall be ARI certified for cooling. Provide [heating] [and] [cooling] units including [non-freeze double tube steam coils] [hot water coils] [and] [direct expansion refrigerant coils with expansion devices and solenoid valves] [chilled water coils] [chilled-hot water coils]. Unit shall include fan section, coil section [with drain pan], [face and bypass damper section,] [opposed blade damper section,] [inlet vortex damper section,] [variable frequency motor controller,] [discharge dampers] filter section and access panels. Insulate interior of casing with manufacturer's standard insulation. Provide nylon bushings for dampers.

- a. Fan section: Provide draw-through fan section including motor, starter, and drives. Provide adjustable sheaves to permit fan capacity variation from 5 percent above to 5 percent below rated capacity.
- b. Coil section: Provide ARI 410 coils and slope for drainage. Provide insulated drain pans under cooling coils and valves. Provide direct expansion refrigerant coils with holding charge of dry nitrogen and seal.
- c. Filter section: Provide UL listed, [25] [51] mm [1] [2] inch thick 30 percent efficient throwaway fiberglass filters, standard dust-holding capacity, 1.8 mls 350 fpm maximum face velocity. [Provide [60] [70] [80] percent efficient bag final filters, 1.8 mls 350 fpm face velocity.] [Provide gasketed hinged access panel with quick opening half-twist latches at end of filter rack.]
- d. Space temperature controls: [Provide digital electronic controls including adjustable programmable thermostats with COOL-OFF-HEAT system switch and AUTO-ON fan switch. Thermostats shall be furnished by unit manufacturer. Provide relays, transformers,

contactors, and control wiring between thermostats and unit.]  
[Provide controls under Section 15901N, "Space Temperature Control Systems."]  
[Provide controls under Section 15910N, "Direct Digital Control Systems."]

- e. Weatherproof casing: Provide removable gasketed panels designed to exclude driving rain for access to fans, coils, filters, compressors, motors, and controls. Provide weatherproof outside air intake louvers or weatherproof hoods with moisture eliminators.
- f. Roof curbs: Provide factory-fabricated galvanized steel roof curbs, wood nailers, insulation, and seal strips in accordance with NRCA RWM curb details for rooftop air-handling units. Roof curbs shall be furnished by unit manufacturer.
- [g. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]
- h. Equipment selection: Air-handling unit (AHU) manufacturer shall certify the capability of the AHU to perform between the cumulative design minimum and maximum airflows of the variable air volume (VAV) terminals. The AHU submittal selection shall be supported by fan curves clearly annotated showing operating points of the minimum and maximum airflow of connected VAV terminals.

#### 2.1.6 Multizone Air-Handling Units

Provide units factory assembled, designed, tested, and rated in accordance with ARI 430. Units shall include multizone damper section, fan section, coil section, filter section, mixing box section, and access panels. Insulate inside of casing with manufacturer's standard insulation.

- a. Multizone damper section: Dampers shall rotate in nylon bearings and shall be interconnected externally with single steel rod to permit zoning in the field. Provide solid zone partitions between the blades with neoprene gasketed stops for positive leakproof sealing of the dampers. Unit manufacturer shall furnish duct clips for attaching damper sections to ducts. [Provide three-deck multizone units with two sets of independent dampers (hot/bypass and cold/bypass) per zone. The dampers shall be interlocked so that the cold deck will not open until the hot deck is completely closed.] [Provide two-deck multizone unit with hot deck or cold deck and bypassing air dampers positioned at 90 degrees offset from each other.]
- b. Fan section: Provide blow-through centrifugal fan section including motor, starter, and drives. Provide adjustable sheaves to permit fan capacity variation from 5 percent above to 5 percent below rated capacity.
- c. Coil section: Provide separate ARI 410 hot deck water coils and cold deck water coils. Seal coils to casing to prevent air leakage around the coils. Partitions between bypass, hot deck water coils, and cold deck water coils shall be factory insulated. Provide insulated drain pan under cooling coils and valves. Balance pressure drops through the hot deck, cold deck, and bypass with factory installed equalizing baffles.
- d. Filter section: Provide UL listed, [25] [51] mm [1] [2] inch

thick 30 percent efficient throwaway fiberglass filters, standard dust-holding capacity, 1.8 mls 350 fpm maximum face velocity. [Provide [60] [70] [80] percent efficient bag final filters, 1.8 mls 350 fpm maximum face velocity.] [Provide gasketed hinged access panel with quick opening half-twist latches at end of filter rack.]

- e. Space temperature controls: [Provide controls under Section 15901N, "Space Temperature Control System."] [Provide controls under Section 15910N, "Direct Digital Control Systems."]

#### 2.1.7 Air-Cooled Water Chillers

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**NOTE: Design chiller systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement). Indicate the equipment operating requirements, including efficiency, on the drawings.**  
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**NOTE: A 20 ton rated water chiller located on the facility roof should be mounted on its own structural steel skid which in turn is supported by spring isolators from structural roof framing. Designers should determine from equipment manufacturers the most practicable method of mounting the equipment on the roof and indicate the configuration on the design drawings.**  
\*\*\*\*\*

Provide single package units factory assembled, designed, tested, and rated in accordance with ARI 550/590 with air-cooled condensers. Provide not less than two independent refrigerant circuits for multi-compressor units. Provide direct expansion shell and tube design, refrigerant circuits, including electric-motor-driven refrigerant compressors with integral crankcase heater, air-cooled condenser, receiver, chiller, piping, controls, and accessories mounted in a cabinet. Provide refrigerant, internal pressure relief device, solenoid valve, combination liquid-line strainer-drier, expansion valve, and service valves. Condenser discharge air shall be in vertical direction. Provide guards to protect condenser fins from mechanical damage. Crankcase heaters are not required when scroll compressors are provided.

- a. Controls: Provide factory-wired digital electronic controls including adjustable programmable thermostat for chilled water temperature control, high-low pressure control, low water temperature safety thermostat, ON-OFF unit switch, and non-recycling pump-down relay.

Controls shall also include maximum operating pressure expansion valves and programming of microprocessor chiller controls or high temperature controller for operation of compressors in cool down mode for start-up or changeover when entering water temperature is in 15.6 to 32.2 degrees C 60 to 90 degree F range.

Provide electrical interlock between water chiller and chilled water pump to prevent chiller from operating unless pump is

running. Provide flow switch or flow sensors in chilled water return piping to stop compressor in event of water flow failure.

Condenser fan electric motors shall be drip-proof, with built-in three-phase overload protection, mounted inside the casing. Compressor motor stoppage due to thermal and pressure overload shall require manual restart. Provide control and interlock wiring.

Provide thermostat controlled electric heater cable for freeze protection down to 17.5 degrees C 0 degree F air temperature. [To operate when ambient exterior air temperature falls below 4.4 degrees C 40 degree F, provide low ambient control and hot-gas bypass.]

b. Weatherproof casing: Provide removable gasketed panels designed to exclude driving rain for access to compressors, motors, and controls.

[c. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.8 Air-Cooled Condensing Units

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**NOTE: A 20 ton rated condensing unit located on the facility roof should be mounted on its own structural steel skid which in turn is supported by spring isolators from structural roof framing. Designers should determine from equipment manufacturers the most practicable method of mounting the equipment on the roof and indicate the configuration on the design drawings.**

\*\*\*\*\*

Provide units factory assembled, designed, tested, and rated in accordance with ARI 365. Units shall be ARI certified. Provide units including electric-motor-driven refrigerant compressors with integral crankcase heater, air-cooled condenser, with refrigerant and holding charge of dry nitrogen and seal. Provide isolation and service valves at refrigerant piping connections to unit. Provide refrigerant, pressure relief valve, solenoid valve, combination filter-dryer, and expansion valves. Condenser discharge air shall be in vertical direction. Provide guards to protect fins from mechanical damage. Provide extension tubing to exterior of unit casing for each lubrication fitting. Provide field adjustable head pressure controls to maintain a minimum head pressure corresponding to 32.2 degrees C 90 degrees F condensing temperature when ambient temperature is 4.4 degrees C 40 degrees F. Crankcase heaters are not required when scroll compressors are provided. Unit shall be manufactured by same manufacturer as the air-handling unit.

a. Controls: Provide factory controls including automatic safety shutdown switches for each compressor for the following hazardous system conditions: refrigerant high pressure, refrigerant low pressure, low oil level, and compressor overload. The switches shall be located in the unit control panel. The cutout switches shall automatically stop the respective compressors and simultaneously ring an alarm bell whenever the pressure within the condenser rises above the predetermined safe point. [Provide

adjustable automatic hot-gas bypass regulator valve, external equalizer tubing, and interconnecting tubing. Field adjust as required after charging. Hot-gas bypass shall be factory fabricated requiring only field connection of factory furnished components.]

- b. Weatherproof casing: Provide removable gasketed panels designed to exclude driving rain for access to fans, coils, filters, compressors, motors, and controls.

- [c. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.9 Room Fan-Coil Air-Conditioners

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**NOTE: Units shall be based on unit capacity of not less than sensible and latent cooling loads, and not greater than 110 percent or 147 W 500 Btuh of sensible cooling loads at maximum fan speed.**  
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Provide units factory assembled, designed, tested, and rated in accordance with ARI 440. Units shall be ARI certified or listed in ARI APD for cooling. Units shall include single hot water and chilled water coil, double width centrifugal fans, three-speed split capacitor motors with integral thermal overload protection, insulated drain pans under cooling coils and valves, and filters. Insulate interior of casing with manufacturer's standard insulation.

- a. Filters: Provide UL listed throwaway fiberglass filters, standard dust-holding capacity.
- b. Space temperature controls: Provide digital electronic controls including adjustable programmable temperature control thermostats with COOL-OFF-HEAT system switch, HIGH-MEDIUM-LOW fan switch, and FAN ONLY switch. When system switch is in OFF position, deenergize automatic valve to stop water flow to coil. Thermostats shall be furnished by unit manufacturer. Provide relays, transformers, contactors, and control wiring between thermostats and unit.
- c. Horizontal units
  - (1) Concealed units: Provide unit mounted filter box with track and hinged access doors with latches. Provide supply air discharge with 25 mm one inch duct collar. Provide return air plenum suitable for bottom or rear return air duct connection as indicated. Provide plenum with duct lining.
  - (2) Recessed units: Provide adjustable recessing frame for flush ceiling mounting. Provide hinged bottom panel with latches for access to filters and fan motors. Provide discharge air outlet with 25 mm one inch duct collar. Provide bottom access panel with stamped return air grille or provide solid bottom access panel and rear return air inlet with 25 mm one inch duct collar as indicated.
  - (3) Cabinet units: Provide hinged bottom panel with latches for access to filters and fan motors. Provide adjustable double



deflection or stamped discharge grilles as indicated. Provide bottom or rear stamped return air grille as indicated.

- d. Vertical units: Provide concealed, recessed, and cabinet units where indicated. Provide unit levelers, subbases, and removable front cover for access to filters and fan motors. [Provide outside air intake boxes with automatic dampers set for L/S cfm indicated in open position] [and weatherproof anodized aluminum louvers].

(1) Recessed unit: Provide removable front cover for access to entire unit. Provide [discharge air and] return air grilles in front cover. [Provide top discharge air outlet with 25 mm one inch duct collar.]

(2) Cabinet unit: Provide removable front, side, and top panels. Provide adjustable double deflection or stamped discharge grille as indicated.

#### 2.1.10 Room Air-Conditioners

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**NOTE: Design air-conditioning systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement). Indicate the equipment operating requirements, including efficiency, on the drawings.**  
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Provide units factory assembled, cooling capacity rating tested, and electrical input rating tested in accordance with AHAM RAC-1. Units shall be AHAM certified or listed in AHAM DCRAC. Provide window air-conditioning units and special wall sleeve suitable for through-the-wall installation of units; do not restrict louvers or cabinet sides. Provide wall sleeves designed to exclude driving rain. Provide installation hardware as recommended by unit manufacturer. Unit chassis shall be removable from inside building without removing cabinet. Provide guards to protect condenser fins from damage. Provide permanent washable air filters, removable without use of tools.

- a. Space temperature controls: Provide HIGH-LOW fan switch, OFF-HIGH-MEDIUM-LOW cooling fan switch, and COOLER-WARMER adjustable temperature control thermostat.
- b. Power cord: Provide manufacturer's standard length three-wire grounding cord and plug.

#### 2.1.11 Packaged Terminal Air-Conditioners

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**NOTE: Design air-conditioning systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement). Indicate the equipment operating requirements, including efficiency, on the drawings.**  
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Provide units factory assembled, designed, tested, and rated in accordance with ARI 310 for cooling. Units shall be ARI certified or rated in ARI APD for cooling. Units shall include refrigeration section, heating section (where indicated), separate outdoor weatherproof louvers, forced ventilation, room cabinet, fans and motors, controls, wall sleeves, filters, dampers, grilles, subbases, leveling device, and power connections. Wall sleeves and installation shall be designed to exclude driving rain. Insulate interior of unit with manufacturer's standard insulation. Unit shall have slide-out chassis easily removed through room cabinet opening. Provide adjustable deflection inside air supply grille. Fan motors shall be permanent-split capacitor type.

- a. Filters: Provide permanent washable air filters or UL rated throwaway fiberglass filters, standard dust-holding capacity; removable through access door or panel.
- b. Safety controls: Provide compressor motors with thermal and overload protection, 5 minute anti-recycle timer, start capacitor kit, and crankcase heater. The above safety controls are not required when scroll compressors are provided.
- c. Heating section: Provide UL or ETL listed electric resistance heaters including internal fusing integral with heaters; fan shall run until heater cools.
- d. Space temperature controls: Provide controls including COOLER-WARMER adjustable temperature control thermostat with COOL-OFF-HEAT system switch and HIGH-MEDIUM-LOW fan switch, and FAN ONLY switch.
- [e. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.12 Packaged Terminal Heat Pumps

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**NOTE: Design heat pump systems for energy efficiency  
in compliance with FEMP/Energy Star requirements  
specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).  
Indicate the equipment operating requirements,  
including efficiency, on the drawings.**  
\*\*\*\*\*

Provide units factory assembled, designed, tested, and rated in accordance with ARI 380. Units shall be ARI certified or rated in ARI APD. Units shall include refrigeration section, additional heating section (where indicated), separate outdoor weatherproof anodized aluminum louvers, forced ventilation, room cabinet, fans and motors, controls, wall sleeves, filters, dampers, grilles, subbases, leveling device, and power connections. Wall sleeves and installation shall be designed to exclude driving rain. Insulate interior of unit with manufacturer's standard insulation. Unit shall have slide-out chassis easily removed through room cabinet opening. Provide adjustable deflection inside air supply grille. Fan motors shall be permanent-split capacitor type.

- a. Filters: Provide permanent washable air filters or UL listed throwaway fiberglass filters, standard dust-holding capacity; removable through access door or panel.

- b. Safety controls: Provide compressor motors with thermal and overload protection, 5 minute anti-recycle timer, start capacitor kit, and crankcase heater. The above safety controls are not required when scroll compressors are provided.
- c. Supplemental heating section: Provide UL or ETL listed electric resistance heaters including internal fusing integral with unit; fan shall run until heater cools. Provide controls to operate heater only when indoor thermostat is in heating mode and outdoor thermostat indicates outside temperature is below 1.7 degree C 35 degrees F or unit balance point, whichever is higher; and when unit is in defrost mode at any outside temperature.
- d. Space temperature controls: Provide controls including adjustable COOLER-WARMER temperature control thermostats with COOL-OFF-HEAT system switch and HIGH-MEDIUM-LOW fan switch, and FAN ONLY switch.
- [e. Special corrosion protection: Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.13 Series Fan Powered Variable Air Volume (VAV) Terminals

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**NOTE: For evaporator variable airflow applications such as VAV or multizone, provisions for capacity control and minimum capacity must be indicated. Capacity control may be compressor unloading or multiple compressors. For minimum capacity control, these applications should be provided with factory installed hot-gas bypass.**  
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Provide units factory assembled, designed, tested, and rated in accordance with ARI 880. Units shall be ARI certified and listed in the ARI APD. Units shall provide a supply air discharge mix by modulation of conditioned primary air and recirculating of return air. Units shall include casing, centrifugal fan and motor, primary VAV damper or valve, electronic volume regulator, discharge air damper, primary air inlet cone with high and low pressure flow sensors, recirculating air filter frames, filter, and electrical disconnect. [Provide hot water heating coils integral to the terminal, or provide insulated hot water coil section attached to the discharge of the terminal.]

- a. Casing: Provide removable full bottom access panels for servicing internal components without disturbing duct connections. Insulate inside of casing with manufacturer's standard insulation. Units shall have recirculating air inlet equipped with filter frame, round primary damper or valve, and unit mounting brackets.
- b. Fans and motors: Provide centrifugal, forward curved, multiblade, fan wheels with direct-drive motors. Motors shall be high efficiency permanent-split capacitor type with thermal overload protection and permanently lubricated bearings. Motors shall have three speeds or be equipped with solid state speed controllers. Provide isolation between fan motor assembly and unit casing. Fan and motor shall be removable through casing access panel.
- c. Flow sensor: Sensor shall be ring or cross type with minimum of two pickup points which average the velocity across the inlet.

Flow measurement shall be within plus or minus 5 percent of rated airflow with 1.5 diameters of straight duct upstream of unit and inlet static variation of 124 to 1240 Pa (gage) 0.5 to 5.0 inches W.G. Flow measuring taps and calibration flowchart shall be supplied with each unit for field balancing airflows.

- d. Primary VAV damper or valve: Galvanized steel damper blade shall close against gasket inside unit. Connect damper to operating shaft with a positive mechanical connection. Provide nylon bearing for damper shaft. Cylindrical die cast aluminum valve inlet tapered to fit round flexible ducts with integral flow diffuser and beveled self-centering disc. Damper or valve leakage at shutoff shall not exceed 2 percent of capacity at 249 Pa (gage) one inch W.G. pressure.
- e. Regulator: Volume regulator shall be electronic. Electronic controls contained in NEMA ICS 6, Type 1 enclosure sealed from airflow. Controls shall be mounted on side of unit or on air valve. System powered regulators shall not be permitted. Volume regulator shall reset primary air volume as determined by thermostat, within upstream static pressure variation noted in paragraph entitled "Flow Sensor." Volume regulators shall be field adjustable and factory set and calibrated to indicated maximum and minimum primary airflows. Volume regulators shall be direct acting and normally [open] [closed] upon loss of pneumatic pressure.
- f. Electrical: Unit shall incorporate single point electrical connection with electrical disconnect. Electrical components shall be UL or ETL listed and installed in accordance with NFPA 70. Electrical components shall be mounted in control box. Units UL or ETL listed as an assembly do not require airflow switch interlock with electric heating coil when factory assembled.
- g. Filters: Provide UL listed throwaway 25 mm one inch thick fiberglass filters, standard dust-holding capacity.

#### 2.1.14 Liquid Cooling Radiators

Provide factory-assembled unit with vertical air discharge. Performance shall meet requirements for heat removal capacity, coolant flow rate (water or percent ethylene glycol), maximum coolant pressure loss through unit, design ambient temperature, and elevation above sea level. Unit shall be complete with supporting frame, cooling core, fans, fan drives, and guards. The cooling core shall be constructed of copper tubes with plate aluminum fins and removable manifold tanks.

[Comply with requirements specified in paragraph "Corrosion Protection For Coastal Installations".]

#### 2.1.15 Cabinet Unit Heaters

Provide units factory assembled, designed, and tested. Units shall include single heating hot water or steam coil, centrifugal fans, three-speed split capacitor motors with integral thermal overload protection, and filters.

- a. Filters: Provide UL listed throwaway fiberglass filters, standard dust-holding capacity.

- b. Space temperature controls: [Provide controls including adjustable room temperature control thermostats with VENT-OFF-HEAT system switch, HIGH-MEDIUM-LOW fan switch, and FAN ONLY switch. When system switch is in OFF position, deenergize automatic valve to stop water flow to coil. Thermostats shall be furnished by unit manufacturer and installed where indicated. Provide relays, transformers, contactors, and control wiring between thermostats, and unit.] [Provide controls under Section 15901N, "Space Temperature Control Systems."] [Provide controls under Section 15910N, "Direct Digital Control Systems."]
- c. Horizontal units: Provide concealed, recessed, and cabinet units where indicated.
  - (1) Concealed units: Provide unit mounted filter box with track and hinged access doors with latches. Provide supply air discharge with 25 mm one inch duct collar. Provide return air plenum suitable for bottom or rear return air duct connection as indicated. Provide plenum with duct lining.
  - (2) Recessed units: Provide adjustable recessing frame for flush ceiling mounting. Provide hinged bottom panel with latches for access to filters and fan motors. Provide discharge air outlet with 25 mm one inch duct collar. Provide bottom access panel with stamped return air grille or provide solid bottom access panel and rear return air inlet with 25 mm one inch duct collar as indicated.
  - (3) Cabinet units: Provide hinged bottom panel with latches for access to filters and fan motors. Provide adjustable double deflection or stamped discharge grilles as indicated. Provide bottom or rear stamped return air grille as indicated.
- d. Vertical units: Provide recessed and cabinet units where indicated. Provide unit levelers, subbases, and removable front cover for access to filters and fan motors. Provide outside air intake boxes with manual dampers and weatherproof anodized aluminum louvers.
  - (1) Recessed unit: Provide removable front cover for access to entire unit. Provide discharge air and return air grilles in front cover.
  - (2) Cabinet unit: Provide removable front, side, and top panels. Provide adjustable double deflection or stamped discharge grille as indicated.

#### 2.1.16 Unit Heaters

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**NOTE: Factory-assembled, propeller or blower type fan electric unit heaters are specified in Section 15768, "Electric Space Heating Equipment."**  
 \*\*\*\*\*

Provide factory-assembled, propeller or blower type fan unit heaters arranged for horizontal or vertical air discharge as indicated. Each unit shall include steam or hot water coil, fan, electric motor, housing, and air discharge vanes or diffusers. Horizontal discharge type units shall have adjustable deflectors for control of horizontal and vertical airflow.

Rotating air deflector assemblies on vertical units where indicated shall be gear driven by separate electric motor and shall rotate when the fan runs. Each unit shall be provided with threaded mounting holes for attaching threaded hanger rods. Fan motor shall be controlled by wall-mounted adjustable thermostat with higher end of scale range factory set at 23.9 degree C 75 degree F. Controls shall be automatic of the on-off type. Provide fan selector switches to provide AUTOMATIC-ON-OFF positions.

#### 2.1.17 Convectors

Provide factory-assembled units including copper-alloy heating coil with plate aluminum fins, non-recessed wall-mounted baseboard type, baked enamel finish enclosure with tamperproof access doors. Provide copper alloy hot water valves with integral temperature sensing, single temperature sensing control element, packing gland type, for automatic thermostatic control of individual convector.

#### 2.1.18 Finned Tube Radiation

Provide factory-assembled units including heating coil with plate fins. Hanger brackets shall have vertical adjustment for pitch of piping and shall have provisions for noiseless operation during expansion and contraction of piping. Enclosure and end caps shall be constructed of steel with baked enamel finish. Provide face operated manual dampers. Provide tamperproof access doors in enclosure. Provide copper alloy hot water valves with integral temperature sensing, single temperature sensing control element, packing gland type, for automatic thermostatic control of individual radiation.

#### 2.1.19 Hot Water Converters

Provide factory-assembled, U-tube units constructed for minimum of 862 KPa (gage) 125 psig working pressure with steam in the shell and water in the tubes. Construct in accordance with ASME BPVC.

#### 2.1.20 Oil-Fired Heating Boilers

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**NOTE: Design boiler systems for energy efficiency in compliance with FEMP/Energy Star requirements specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement). Indicate the equipment operating requirements, including efficiency, on the drawings.**  
\*\*\*\*\*

Provide units factory assembled, self-contained low pressure boiler, suitable for 103 kPa (gage) 15 psig steam and 207 KPa (gage) 30 psig hot water. Units shall conform to UL 726 and as specified herein. Provide integral draft fan having adequate capacity for the boiler as installed. Use of tubulators or other devices inside the tubes will not be permitted. Provide automatic water feeding device for maintaining proper water level. Provide breeching from boiler to stack. Boiler, burners, breeching, fuel oil tanks, and piping shall conform to NFPA 31 for installation.

- a. Burners: UL 296, integral burner with cadmium cell flame retention, Grade No. 2 fuel oil. Burners shall be specifically designed for the boiler furnished.

- b. Tankless domestic water heater: Provide as part of boiler for intended service. Provide heater with water temperature-regulating valve and controls.
- c. Boiler breeching and stack: Provide size as recommended by boiler manufacturer or as indicated. Provide prefabricated all-fuel multi-wall type UL listed for oil-fired boilers.
- d. Fuel systems: Fuel oil piping shall be steel piping, except fuel oil supply and return piping may be copper tubing with flared fittings or compression type fittings.
- e. Fuel oil valves: Provide valves with threaded end connections or compression type end connections.
  - (1) Gate valves and check valves: MSS SP-80, Class 125.
  - (2) Angle check valves: Double poppet with metal-to-metal seat, cast-iron body, bronze poppets and seats, Buna-N O-rings, and brass screen.
- f. Underground fuel oil storage tank: UL 1316, double-wall glass fiber reinforced polyester tank. Provide [automatic electronic] [manual] leak monitoring and fuel level system. Provide tank with whistle vent alarm.
- g. Aboveground fuel oil storage tank: UL 142 welded steel tank.

#### 2.1.21 Pumps

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**NOTE: Design pumping systems for energy efficiency  
 in compliance with FEMP/Energy Star requirements  
 specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).  
 Indicate the equipment operating requirements,  
 including efficiency, on the drawings.**  
 \*\*\*\*\*

- a. In-line pumps: Provide pumps constructed of manufacturer's standard materials suitable for chilled water and hot water heating systems. Pumps shall have mechanical seals and drip-proof electric motors.
- b. Duplex condensate pumping units: Provide pumps and receiver constructed of manufacturer's standard materials suitable for hot condensate water, mounted on common base, complete with float controls and mechanical alternator.
- c. End suction water pumps: Pumps shall be single stage centrifugal, with mechanical seals and drip-proof electric motors. Impeller shall be bronze. Other pump parts shall be manufacturer's standard materials provided with bronze impeller pump. Provide threaded suction and discharge pressure gage tapping with square-head plugs. Provide flexible coupling with steel cover guard on base-mounted pumps. Base-mounted pump, coupling guard, and motor shall each be bolted to a fabricated steel base which shall have bolt holes for securing base to supporting surface. Close-coupled pump shall be provided with integrally cast or fabricated steel feet with bolt holes for securing feet to

supporting surface.

- d. Pump suction diffuser: Casing shall include an angle type body of cast iron. Unit shall have internal straightening vanes, strainer with minimum 6.35 mm 0.25 inch openings, and auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal. Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Blowdown port and plug shall be provided on unit casing. Provide a magnetic insert to remove debris from system.

#### 2.1.22 Exhaust Fans

##### 2.1.22.1 Centrifugal Exhaust Fans (Wall or Roof)

AMCA 210 with AMCA seal. Provide centrifugal type exhaust fans [, spark-proof] with aluminum housing, fan wheel, and bird screen. Motors shall be completely shielded from the airstream. Provide exhaust opening and gravity closing type automatic backdraft dampers. [Provide NRCA RWM roof curb for roof mounted exhaust fans as recommended by fan manufacturer.] [Provide with] [disconnect] [and] [speed controller]. Provide [v-belt] [and] [direct] drive exhaust fans as indicated.\

##### 2.1.22.2 Propeller Wall Fans

AMCA 210 with AMCA seal. Provide [direct-connected motor.] [or] [v-belt driven with external belt guards and adjustable motor mounts.] Provide with fan guard, [disconnect] [and] [backdraft damper.] Propeller shall be statically and dynamically balanced.

##### 2.1.22.3 In-Line Centrifugal Fans

AMCA 210 with AMCA seal. Provide welded steel casings, centrifugal backward inclined blades, [stationary discharge conversion vanes,] [internal and external belt guards and adjustable motor mounts] [direct drive]. Inlet and outlet connections for fan casings to ductwork and equipment casings, may be of the slip fit or flanged type. [Provide guards for discharges. Rate fans with guards in place.] [Air shall enter and leave the fan axially.] Inlet shall be streamlined [and conversion vanes shall eliminate turbulence and provide smooth discharge airflow.] Enclose fan bearings and drive shafts, and isolate from the airstream. Fan bearings shall be mechanically sealed against dust and dirt and shall be self-aligning, pillow block ball or roller type. Motor and drive shall be provided by fan manufacturer. [Provide with] [disconnect,] [speed controller,] [backdraft damper,] [and] [vibration isolated hanging rod and hardware].

##### 2.1.22.4 Upblast Exhaust Fan

AMCA 210 with AMCA seal. For fume and vapor removal provide [spark-proof] upblast centrifugal type [belt] [or] [direct] exhaust fans [as indicated] with aluminum weatherproof housing the vapor shall be out of the exhaust airstream and cooled by clean outside air. [Provide Class B or H insulated vapor for high heat applications.] [Provide Class 1, Group D explosion-proof motors.] Provide aluminum fan wheel [with acid-resistant Eisenheiss or Heresite coating.] The fan assembly shall be provide with vibration isolators. Provide fan with an integral disconnect, [NRCA RWM



roof curb], [and] [grease through].

#### 2.1.22.5 Utility Set(s)

AMCA 210 with AMCA seal. Provide single width, single inlet blower with backward inclined, non-overloading centrifugal wheel constructed of heavy gage steel. The housing shall be of heavy gage steel with airtight lock seam construction. Provide a weatherhood to protect the motor and drive. Provide [direct drive] [or] [v-belt driven] [exhaust] [and] [supply] fans [as indicated]. [Belt driven fans shall be provided with an adjustable motor plate.] [Provide with [disconnect,] [manual starter switch,] [vibration isolators,] [and] [backdraft damper].]

#### 2.1.22.6 Bathroom Exhaust Fans

UL 507 and UL listed for ceiling installation, HVI (Home Ventilating Institute) certified, with AMCA seal.

#### 2.1.23 Direct Vent Gas-Fired Central Furnaces

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**NOTE: Design furnace systems for energy efficiency  
in compliance with FEMP/Energy Star requirements  
specified at [www.eren.doe.gov/femp/procurement](http://www.eren.doe.gov/femp/procurement).  
Indicate the equipment operating requirements,  
including efficiency, on the drawings.**  
\*\*\*\*\*

Provide factory assembled, self-contained, forced circulation, natural gas-fired air heating, direct vent (condensing) central furnaces with direct vent sealed combustion system using 100 percent outdoor air, and designed to distribute air through ducts for space heating and cooling. Provide electronic pilot ignition system. Unit shall be factory wired with both cooling and heating controls. Unit shall be design certified by American Gas Association, GAMA efficiency rating certified, and listed in GAMA CDCER for gas central furnaces. Minimum AFUE shall be 90 percent. Provide UL listed throwaway 25 mm one inch thick fiberglass filter in return air to each unit. Provide 20- to 30-volt digital heating and cooling space temperature control thermostat with manual changeover. Provide natural gas steel piping, PVC vent and combustion air piping, and PVC condensate drain piping sized as recommended by furnace manufacturer. Provide cooling (evaporator) coil units and cabinets suitable for use with furnace and as specified in paragraph entitled "Split-System Air-Conditioners."

#### 2.1.24 Ceiling Hugger Type Fans

UL 507 and UL listed ceiling hugger type fans for close-to-ceiling installation, minimum of four 1320 mm 52 inch diameter fan blades, three-speed pull chain fan motor switch, reversing switch, and light kit adaptable. Provide special fan support including metal electrical ceiling outlet box designed to support the weight of the fan and light assembly, and to prevent fan wobbling and vibrating at all fan speeds. Secure fan support with minimum of two metal hex head screws for each connection. Provide white opal glass schoolhouse type globe light kit to match fan.

#### 2.1.25 Range Hoods

UL 507 and UL listed, with AMCA seal, separately switched two-speed exhaust

fan and lights. Fan capacity shall be 75.5 L/S 160 cfm with maximum sound level of 5.6 sones. Provide 762 mm 30 inch stainless steel range hood with easily removable washable metal filter and zinc-coated steel ducts to exterior of building with weatherproof grille.

#### 2.1.26 Outside Air Intake [and] [Exhaust] Hoods

Low-silhouette, curb-mounted, dome-type roof [intake] [exhaust] unit equipped with waterproof top. Provide a removable roof constructed of not less than 2.07 mm 0.081 inch thick [aluminum] [or] [galvanized] steel sheet insulated with 2.07 mm 0.081 inch thick glass fiber with vapor barrier attached to underside of roof. Internally brace the unit with not less than 51 by 51 by 3.19 mm 2 by 2 by 1/8 inch aluminum or galvanized steel angles. Provide curb tie-downs and bird screens. The entire assembly shall have been factory tested to withstand a 202 kmph 125 mph wind force. Provide [aluminum] [or] [stainless steel] bolts or screws in the assembly.

#### [2.2 Corrosion Protection For Coastal Installations

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NOTE: Specify corrosion protection for exterior HVAC equipment, including air handling units, heat exchanger coil surfaces, equipment casings, air-cooled water chiller coils, heat pumps, and air conditioning units, that is exposed to the weather within 5 miles of a sea (salt) water coast.

At these coastal locations, this corrosion protection is also required on HVAC equipment within buildings that are subject to the outside weather conditions. Specifically, equipment requiring protection is defined as the first HVAC equipment (excluding louvers) met by the outside air in the supply air ductwork system.

Specifier shall survey the HVAC equipment market place, find and specify the manufacturer's standard off-the-shelf anti-corrosion options for "coastal" or "sea coast" installations. Specify the various systems (utilizing the word "or") offered by three competitive equipment selections. This approach is by far less costly than specifying custom corrosion protection.

Manufacturer's standard off-the-shelf anti-corrosion options for "coastal" or "sea coast" installations also vary with type and size of HVAC equipment.

After thorough investigation of the commercial market, determines manufacturer's standard off-the-shelf anti-corrosion options are not available for the selected equipment, contact the Mechanical Design Branch, LANTNAVFACENGCOM for consultation if the need for this protection is considered mandatory by the station.

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NOTE: For installations at MCAS Cherry Point and MCB Camp LeJeune, including New River, and installations at NAS Oceana including Dam Neck, specify corrosion protection for all outside, and specific inside HVAC equipment exposed to the weather. Follow the guidance specified in the criteria NOTE above.

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## 2.3 ELECTRICAL

### 2.3.1 Electrical Motors, Controllers, Contactors, and Disconnects

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NOTE: If fan powered variable air volume (VAV) terminals are provided in the HVAC systems, the associated central air handler will probably have a variable frequency drive covered by the requirements in brackets at the end of this paragraph.

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Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Section 16402N, "Interior Distribution System." Provide electrical connections under Section 16402N, "Interior Distribution System." Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section. [Provide variable frequency drive (VFD) systems in compliance with Section 16261N, "Variable Frequency Drive Systems Under 600 Volts."]

### 2.3.2 Electrical Work

Provide under Section 16402N, "Interior Distribution System." [Provide control wiring under Section 15901N, "Space Temperature Control Systems."]  
[Provide control wiring under Section 15910N, "Direct Digital Control Systems."]  
[Provide control wiring under this section in accordance with NFPA 70.]

## 2.4 METAL DUCT SYSTEMS

Provide shop-fabricated ductwork. Fabricate, construct, brace, reinforce, install, support, and seal ducts and accessories in accordance with SMACNA HVACMF. Provide rectangular ductwork for low pressure applications; round and flat oval ductwork for medium and high pressure applications as indicated. Cover duct transverse joints with single component synthetic rubber type compound suitable for use with passivated coating on zinc-coated steel. Lap joints in direction of flow. Provide ducts straight and smooth on inside with neatly finished airtight joints. Provide air supply and return openings in ducts with air diffusers, registers, or grilles.

### 2.4.1 Ducts of Pressure Classes 746 to 2490 Pa (Gage) 3 to 10 Inch WG

Construct ducts of [zinc-coated steel conforming to ASTM A653/A653M coating designation G90] [stainless steel].

#### 2.4.1.1 Construction

Duct construction, metal gages, and hangers and support reinforcements shall conform with the SMACNA HVACMF. Ducts shall not pulsate or vibrate when in operation. Pressure sensitive tape shall not be used as a primary sealant on ductwork. Duct air leakage shall be less than that allowed by SMACNA HVACTM for the duct pressure class, duct seal class, and duct leakage class indicated. Curved elbows shall have a centerline radius not less than 1 1/2 times the width of ducts.

#### 2.4.1.2 Joints

Construct joints to meet the requirements of the leakage test specified herein. Duct components shall fit so that joints are not mismatched. Do not use duct sealant and tape to compensate for mismatched connections. Longitudinal locks or seams known as "button-punch snap-lock" will not be permitted. Apply fire-resistant sealing compound to exposed male part of fittings collars so that sealer will be on inside of joint and fully protected by the metal of the duct and fittings. Apply one brush coat of sealing compound over outside of joint to at least 51 mm 2 inch band width covering screw heads and joint gap. When tape is used, apply a single wrap of a duct tape over the wet sealer. Tape provided shall be recommended by the sealer manufacturer to permit proper curing of the sealer. Dents in the male portion of the slip fitting collar will not be acceptable.

#### 2.4.1.3 Fittings

Square elbows, round elbows, fittings, branch take-offs, transitions, splitters, duct volume dampers, fire dampers, flexible connections, and access doors shall conform with the SMACNA HVACMF, Section 2.

- a. Test holes: Provide factory fabricated, airtight, and noncorrosive test holes with screw cap and gasket. Provide extended neck fittings to clear insulation.
- b. Round elbows: Provide 45 degree and 90 degree round elbows of two piece die stamped construction for ducts 203 mm 8 inches or less in diameter. For ducts over 203 mm 8 inches in diameter, provide 5 mitered piece for 90 degrees and 3 mitered piece for 45 degrees.

#### 2.4.1.4 Round and Oval Ducts

SMACNA HVACMF, Section 3.

#### 2.4.1.5 Rectangular Ducts

Make joints between sections of duct and between ducts and fittings with either gasketed flanged connection, welded flange joints, or other joints recommended in SMACNA HVACMF, Section 1, and reinforce at the joints and between the joints as recommended.

#### 2.4.1.6 Sound Attenuators

Provide factory fabricated attenuators that will reduce the rated sound pressure level of the fan down to at least 65 decibels in the 250 Hz (third octave band) center frequency by using a reference sound source calibrated in decibels of sound power at 10 to 12 watts. Maximum permissible pressure drop shall not exceed 157 Pa 0.63 inch of water. Attenuators to be

constructed airtight when operating under an internal pressure of 2490 Pa 10 inches of water. The air-side surface shall be capable of withstanding air velocity of 51 m/s 10,000 feet per minute. When attenuators are submitted for approval, provide manufacturer's product data verifying the net sound reduction values. Sound absorbing material shall conform with ASTM C1071, Type I or II. Provide suitable duct-transition sections for connections to ductwork.

- a. Net sound reduction values: Conform with the following:

Minimum Net Sound Reduction Values  
Sound Pressure Level dB  
(Reference Sound Power at 10-12 Watts)

Octave Pass Band	2	3	4	5	6	7
Center Frequency (Hz)	125	250	500	1000	2000	4000
Noises Reduction (db)	11	16	19	30	40	32

- b. Factory-fabricated sound attenuators (traps): Provide sound attenuators constructed of galvanized sheet steel casing and sound absorbing material covered with an internal perforated zinc-coated metal liner. Sound absorbing materials shall be faced with glass fiber cloth and hold in compression to prevent settling. The internal perforated metal liner shall be not less than 0.7 mm 24 gage, with perforations not larger than 3.97 mm 5/32 inch in diameter providing a net open area not less than 22 percent of the surface. Attenuators shall be insulated to prevent sweating.
- c. Factory-fabricated sound-attenuator ducts: Sound-attenuator ducts may be provided in lieu of sound attenuators (traps). Comply with requirements specified herein for sound attenuators. Construct each double-walled duct and fitting of an outer zinc-coated metal pressure shell with 25 mm one inch thick acoustical blanket insulation and an internal perforated zinc-coated metal liner. Install sufficient length of run to obtain the noise reduction value specified. Provide product data from manufacturer verifying that the sound reduction value specified will be obtained within the length of duct run provided. Noise reduction data shall include effects of flanking paths and vibration transmission. The internal perforated zinc-coated metal liner shall be not less than 0.7 mm 24 gage, unless ribbed, not less than 0.47 mm 28 gage for the duct liner and not less than 0.55 mm 26 gage for the fitting liner with perforations not larger than 2.38 mm 3/32 inch diameter. Seal joints as specified in paragraph entitled "Round and Oval Ducts." [Rigid molded fiber-glass inserts with the air side surface [PVC] [neoprene]-coated, when complying with requirements specified herein, may be used in lieu of internal preformed zinc-coated metal liner.]

#### 2.4.2 Ducts of Pressure Classes Less than 746 Pa (Gage) 3 Inch WG

Construction, metal gage, hangers and supports, and reinforcements shall conform with SMACNA HVACMF, except that ducts with pressure classifications below 497 Pa (gage) 2 inch water gage that are located outside of the conditioned space shall have a seal Class C. Ductwork shall be airtight and shall not vibrate or pulsate when system is in operation. Pressure sensitive tape shall not be used as a primary sealant on ductwork with pressure classifications above 249 Pa (gage) one inch water gage. Duct air leakage shall be less than that allowed by SMACNA HVACTM for the duct

pressure class, duct seal class, and duct leakage class indicated. Construct ductwork of [zinc-coated steel conforming to ASTM A653/A653M coating designation G90] [or] [aluminum]. Exhaust ductwork exhausting non-residential kitchens shall be constructed of ASTM A167 stainless steel with welded seams and joints except the flanged connection to the exhaust fan.

#### 2.4.2.1 Curved Elbows

Make a centerline radius not less than 1 1/2 times the width or diameter of the duct.

#### 2.4.2.2 Laps

Make laps at joints in the direction of airflow. Space button-punch or bolt-connection in standing seams at fixed centers not greater than 152 mm 6 inches. Longitudinal locks or seams, known as "button-punch snap lock," may be in lieu of Pittsburgh Lock.

#### 2.4.2.3 Fittings

Elbows, vaned elbows, take-offs, branch connections, transitions, splitters, volume dampers, fire dampers, flexible connections, and access doors shall conform with SMACNA HVACMF, Section 2. Provide factory fabricated, airtight, and noncorrosive test holes with screw cap and gasket.

#### 2.4.2.4 Acoustical Duct Lining

Provide where indicated. Provide ASTM C1071 fiberglass duct lining, minimum of 25 mm one inch thick, with black-pigmented fire-resistant coating on side exposed to airstream. Secure to duct interior with 100 percent coverage of adhesive and with mechanical fastening devices, spaced in accordance with SMACNA HVACMF. Provide metal nosing at duct lining beginnings and endings.

#### 2.4.2.5 Preformed Duct Liner

Provide preformed round duct liner minimum of 25 mm one inch thick, with black-pigmented fire-resistant, anti-microbial agent designed for insertion in round ducts may be used in the sizes commercially available. Provide duct liner sections with slip-lap joints not less than 50 mm 2 inches wide. Make joints in accordance with manufacturer's printed instructions. Furnish fire-resistant adhesive to field-coated joints when recommended by the manufacturer to prevent delamination or erosion at joints. Tabular sections of duct liner shall fit the metal duct snugly and without gaps between duct-liner sections.

#### 2.4.2.6 Factory-Fabricated Sound-Attenuator Ducts

Provide double-walled duct and fitting of an outer zinc-coated metal pressure shell with 25 mm one inch thick acoustical blanket insulation and an internal perforated zinc-coated metal liner. Install sufficient length of run to obtain the noise reduction value specified. Submit product data from manufacturer verifying that the net sound reduction values specified will be obtained within the length of duct run provided. The internal perforated zinc-coated metal-liner shall be not less than 0.7 mm 24 gage, unless ribbed, then not less than 0.47 mm 28 gage for the duct liner and not less than 0.55 mm 26 gage for the fitting liner with perforations not larger than 2.38 mm 3/32 inch diameter. Seal joints as specified in

paragraph entitled "Round and Oval Ducts." [Rigid molded fiberglass inserts with the air-side surface [PVC] [neoprene]-coated, if complying with requirements specified herein, may be used in lieu of internal perforated zinc-coated metal liner.] Each sound attenuator duct system shall comply with the following requirements:

Minimum Net Sound Reduction Values  
Sound Pressure Level dB  
(Reference Sound Power at 10-12 Watts)

Octave Pass Band	2	3	4	5	6	7
Center Frequency (Hz)	125	250	500	1000	2000	4000
Noises Reduction (db)	11	16	19	30	40	32

#### 2.4.3 Flexible Duct Connectors

Provide a minimum of design pressure rated plus 124 Pa (gage) 0.5 inch W.G. static pressure airtight flexible duct connectors at duct connections to each air-conditioning unit, air-handling unit, exhaust fan, and ventilating fan. Support connectors at each end with metal angle frame bands, securely bolt in place. Provide not less than 0.60 L 20 ounce glass fabric duct connectors coated on both sides with neoprene.

#### 2.4.4 Turning Vanes

Provide fabricated tees and square elbows with double walled turning vanes in accordance with SMACNA HVACMF for vaned elbows.

#### 2.4.5 Dampers

Provide factory manufactured opposed blade adjustable manual dampers where indicated for duct heights of 305 mm 12 inches and larger. Provide factory manufactured single leaf dampers for duct heights less than 305 mm 12 inches.

Provide damper shafts with 51 mm 2 inch standoffs to clear 51 mm 2 inches of duct insulation with bearings at both ends of the shafts. Provide adjustment quadrant with indicator and locking devices. Provide galvanized steel dampers 0.15 mm thicker one gage heavier than duct in which dampers are installed. [Provide automatic dampers under Section 15901N, "Space Temperature Control Systems."] [Provide automatic dampers under Section 15910N, "Direct Digital Control Systems."]

#### 2.4.6 Diffusers, Registers, and Grilles

Provide factory-fabricated metal units with edges rolled or rounded where exposed to view, and factory primed with white enamel finish. Do not provide dampers in or on diffusers, registers and grilles. Provide each unit with rubber or plastic installation gaskets. Diffusers in same room shall have same face design.

- a. Diffusers: Provide round, square, or rectangular diffusers as indicated. Ceiling diffusers shall be designed to deliver air in a horizontal direction. Provide baffles or other devices as required for proper air distribution pattern.
- b. Registers: Provide double deflection supply registers arranged to control air direction, throw, and drop. Exhaust and return air registers shall have single set of nondirectional face bars or vanes having the same appearance as supply registers. Provide face bars or vanes spaced not more than 19.05 mm 0.75 inch on

center and not less than 15.75 mm 0.62 inch depth.

- c. Grilles: Provide as specified for registers without air-volume-control dampers.

#### 2.4.7 Outside Air Intake Louvers

[Louvers shall bear AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. Maximum pressure drop shall be 24.9 Pa (gage) 0.1 inch W.G.. Louvers shall have maximum water penetration of 0.0637 liters per square meter 0.20 ounce per square foot of free area at free velocity of 4.1 m/s 800 fpm. Provide aluminum alloy with anodized finish frames and blades assembled with stainless steel screws, including 12.7 mm 0.5 inch mesh aluminum screen mounted in extruded aluminum frame.] [Louvers are specified in Section 10201N, "Metal [Wall] [and] [Door] Louvers."]

#### 2.4.8 Access Doors

Provide for access to volume dampers, fire dampers, plenum chambers, and where indicated. Provide each door with double wall zinc-coated steel construction, gasketed airtight, with continuous hinges and cam latches. Insulate access doors with 25 mm one inch thick rigid insulation. Provide 305 by 305 mm 12 by 12 inch door, except where larger sizes are indicated, or provide 305 mm 12 inches by height of duct when duct is less than 305 mm 12 inches high. Provide keyed-alike 90 degree turn cam locks on each access door in sleeping rooms; furnish three keys.

#### 2.4.9 Fire Dampers

UL 555 and NFPA 90A. Dampers shall be listed in UL BMD. Dampers when open shall not protrude into the ducts.

#### 2.4.10 Duct Heaters

[ARI 410, steam or hot water coils.] [Electric heating coils shall have aluminized steel flanged frame for duct mounting, complete with terminal box, high limit thermal cutout bulb, and open resistance type heating elements. Coils shall have an airflow switch to keep heaters from operating with no-airflow. Provide controls to keep fan running until heater cools. Provide wire type heating elements insulated from metal by ceramic bushings. Provide UL or ETL listed or FM approved duct heaters.]

#### 2.4.11 Flexible Round Ducts

UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Fire hazard rating of duct assembly shall not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 497 kPa (gage) 2 inches W.G. positive and 373 kPa (gage) 1.5 inches W.G. negative. Flexible round duct length shall not exceed 1525 mm 5 feet. Secure connections by applying adhesive for 51 mm 2 inches over rigid duct, apply flexible duct 51 mm 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

- a. Inner duct core: Flexible core shall be interlocking spiral or helically corrugated and constructed of zinc-coated steel, aluminum, or stainless steel; or shall be constructed of inner liner of continuous galvanized spring steel wire helix fused to



continuous, fire-retardant, flexible vapor barrier film, inner duct core.

- b. Insulation: Inner duct core shall be insulated with mineral fiber blanket type flexible insulation, minimum of 25 mm one inch thick. Insulation shall be covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

#### 2.4.12 Linear Diffusers

Joints between diffuser sections shall appear as hairline cracks. Provide alignment slots for insertion of key strips or other concealed means to align exposed butt edges of diffusers. [Equip with plaster frames when mounted in plaster ceiling.] Do not use screws and bolts in exposed face of frames or flanges. Frames and flanges exposed below ceiling shall be metal-filled and ground smooth. Furnish separate pivoted or hinged adjustable air-volume-damper and separate air-deflection blades.

#### 2.4.13 Field-Installed TAB Test Ports

Test ports required for testing by the TAB engineer shall be located in the field by the TAB engineer during TAB field work. It shall be the responsibility of the ductwork contractor to provide and install test ports as required by the TAB engineer.

#### [2.4.14 Kitchen Exhaust Ductwork

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**NOTE: The requirements in NFPA 96 pertaining to enclosures around kitchen exhaust ducts shall be shown on the drawings.**

**SMACNA HVACMF does not cover negative pressures in excess of 3 inches water gauge. If the static pressure within the duct will exceed 3 inches negative, then the spacing and duct thickness must be indicated on the drawings and the paragraph accordingly.**

\*\*\*\*\*

Ducts conveying smoke and grease laden vapors shall conform to requirements of NFPA 96 as modified and supplemented by this specification. Seams, joints, penetrations, and duct-to-hood collar connections shall have a liquid tight continuous external weld. Duct material shall be minimum 1.3 mm (18 gauge), 18 gauge, Type 304L or 316L, stainless steel. Duct construction shall include external perimeter angle sized in accordance with SMACNA HVACMF; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Angles, pipe couplings, frames, and bolts shall be same material as that specified for the duct.]

#### 2.5 PIPING SYSTEMS

Provide the following pipe and fittings. Provide dielectric fittings, unions or flanges between steel piping and copper tubing for all piping sizes; except that copper alloy valves and strainers may be used without

dielectric fittings, unions or flanges. Water piping sizes 100 mm 4 inches and smaller shall be copper tubing. Water piping sizes larger than 100 mm 4 inches shall be copper tubing or steel piping.

#### 2.5.1 Copper Tubing Piping Systems

Provide copper tubing for the following piping systems, except water piping sizes larger than 100 mm 4 inches shall be copper tubing or steel piping. Copper tubing of sizes larger than 100 mm 4 inches shall have brazed joints.

##### 2.5.1.1 Chilled water, chilled-hot water, and hot water piping.

Provide ASTM B88M ASTM B88, Type L or M for aboveground piping, Type K for buried piping, with ASME B16.18 or ASME B16.22 solder joint fittings, unions, and flanges; provide adapters as required. Provide ASTM B42 copper pipe nipples with threaded end connections. Provide ASTM B32, 95-5 tin-antimony solder, or provide Plumbing Code approved lead-free solder.

##### 2.5.1.2 Aboveground Fuel Oil Supply and Return Piping

Provide ASTM B88M ASTM B88 tubing, Type L or M, with ASME B16.26 flared fittings or compression type fittings or steel piping.

##### 2.5.1.3 Copper Cold Drain Piping

Provide copper tubing in accordance with paragraph entitled "Soldered Joint Copper Tubing" for Piping Sizes 25 mm One Inch and Smaller. Provide ASTM B306 copper tubing and ASME B16.23 solder joint fittings for piping sizes larger than one inch. In lieu of copper tubing, 32 mm 1.25 inch Schedule 40 polyvinyl chloride (PVC) plastic pipe, fittings, and solvent cement may be provided.

#### 2.5.2 Refrigerant Tubing

Provide ASTM B280, cleaned, dehydrated, and sealed. Provide ASME B16.22 solder joint refrigerant fittings and adapters. Provide silver brazing alloy solder and silver brazing alloy flux. During brazing operations bleed a small amount of dry oil-free nitrogen continuously through the refrigerant tubing. Provide ASME B16.26 flared fittings.

#### 2.5.3 Buried Preinsulated Water Piping

[Requirements for buried preinsulated water piping is specified in Section 02557N, "Exterior Buried Preinsulated Water Piping."] [Provide buried preinsulated water piping in conduit complete and ready for operation. Install in accordance with fabricator's published literature. Provide copper tubing for carrier piping; carrier piping sizes larger than 100 mm 4 inches may be steel piping. Minimum depth of cover shall be 0.61 m 2 feet.

- a. Factory-applied insulation: Provide polyurethane or polyisocyanate insulation, rated for not less than 121 degrees C 250 degrees F service, completely filling the space between carrier pipe and conduit.
- b. Factory-applied conduit: Provide each section of carrier pipe with insulation and conduit complete with waterproof conduit caps at both ends. Mark each section of conduit with fabricator's name, product identification, and publications to which the items conform. Provide same type of insulation and conduit material

over field-insulated joints and fittings; provide waterproof shrink sleeves over field-insulated joints to overlap not less than 152 mm 6 inches of each conduit section.

- c. Bedding: Accurately grade trench bedding with minimum of 152 mm 6 inches of sand. Backfill sand to minimum of 152 mm 6 inches above and below conduit. Lay bedding to firmly support conduit along entire length.
- d. Buried utility warning tape: Provide detectable tape for warning of buried piping.]

#### 2.5.4 Steel Piping Systems

Provide steel piping for the following piping systems.

- a. Steam and condensate piping.
- b. Fuel oil supply, return, vent, and fill piping.
- c. Gas piping.

##### 2.5.4.1 Steel Pipe

Provide ASTM A53/A53M Type E or Type S, or ASTM A106 steel pipe; except ASTM A53/A53M, Type F steel pipe may be provided for water pipe sizes larger than 100 mm 4 inches and for steam pipe less than 690 kPa (gage) 100 psig. Provide Weight Class STD or Schedule No. 40 black steel pipe for welding end connections. Provide Weight Class XS or Schedule No. 80 black steel pipe for steam condensate piping systems and for all piping with threaded end connections.

##### 2.5.4.2 Steel Pipe Fittings

Provide ASME B16.3 or ASME B16.11 threaded fittings, and ASME B16.39 threaded unions. Provide ASME B16.9 butt welding fittings of the same material and weight as the piping in which fittings are installed; provide backing rings compatible with piping materials being butt welded. Provide ASME B16.11 socket welding fittings. Only welded fittings are acceptable in fuel oil piping installed below grade.

##### 2.5.4.3 Steel Pipe Unions

Provide ASME B16.39, Class 150, unions with threaded end connections on one side of threaded valve in steel piping systems.

##### 2.5.4.4 Steel Pipe Flanges

Provide ASME B16.5, Class 150 welding neck flanges. Extend bolts no less than two full threads beyond the nut with the bolts tightened to the required torque.

- a. Gaskets: Provide one piece factory cut gaskets suitable for the intended service. Provide full-face gaskets for flat-face flanged joints, and ring gaskets for raised-face flanged joints.
- b. Bolts: Provide ASTM A193/A193M, Grade B7 bolts.
- c. Nuts: ASTM A194/A194M, Grade 7.

- d. Washers: Provide steel flat circular washers under bolt heads and nuts.

#### 2.5.4.5 Direct Buried Steel Piping

Provide pipe and fittings with exterior coal tar epoxy painting system.

#### 2.5.5 Dielectric Connections

Provide at connections between copper and ferrous metal piping materials. ASTM F441/F441M, Schedule 80, CPVC threaded pipe nipples, 100 mm 4 inch minimum length, may be provided for dielectric connections in pipe sizes 50 mm 2 inches and smaller.

#### 2.5.6 Valves

Valves shall have flanged end connections, except valves smaller than 65 mm 2.5 inches may have threaded end connections with a union on one side of the valve. Solder end connections may be used for connections between copper alloy valves and copper tubing.

##### 2.5.6.1 Gate Valves

MSS SP-80, Class 125, except sizes 65 mm 2.5 inches and larger shall conform to MSS SP-70, Class 125.

##### 2.5.6.2 Globe and Angle Valves

MSS SP-80, Class 125, except sizes 65 mm 2.5 inches and larger shall conform to MSS SP-85, Class 125.

##### 2.5.6.3 Check Valves

MSS SP-80, Class 125, swing check; except sizes 65 mm 2.5 inches and larger shall conform to MSS SP-71, Class 125.

##### 2.5.6.4 Butterfly Valves

MSS SP-67, except sizes 65 mm 2.5 inches and larger shall have lugged or wafer body designed for installation between ASME Class 150 flanges. Valves shall have two-position lever handles.

##### 2.5.6.5 Ball Valves

Full port design, copper alloy body, except sizes 65 mm 2.5 inches and larger shall be cast-iron body. Valves shall have two-position lever handles. Ball valves may be provided in lieu of gate valves.

##### 2.5.6.6 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

##### 2.5.6.7 Air Venting Valves

Provide copper alloy body valves with automatic or manual air vent as indicated.

## 2.5.7 Specialty Valves

### 2.5.7.1 Combination Pressure and Temperature Relief Valves

ANSI Z21.22, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

### 2.5.7.2 Water Pressure Reducing Valves

ASSE 1003, copper alloy body, automatic re-seating, with test lever.

### 2.5.7.3 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

### 2.5.7.4 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 862 kPa (gage) 125 psig at 87.8 degrees C 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tapings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the liters per second gallons per minute flow for each differential pressure reading.

### 2.5.7.5 Backflow Prevention Assemblies

Provide reduced pressure principle type backflow prevention assemblies which are approved by and has a current "Certificate of Approval" from the FCCCHR-USC. Listing of the particular make, model/design, and size in the current FCCCHR-USC will be acceptable as the required proof.

### 2.5.7.6 Refrigerant Valves

ASME B31.5, and shall be copper alloy. Provide valves in each system for servicing and for isolating system components in compliance with ASHRAE 15.

\*\*\*\*\*  
**NOTE: Use ASME Class 300 for Little Creek Naval Amphibious Base, Virginia Beach, Virginia.**  
\*\*\*\*\*

## [2.5.8 Valves for Steam 690 kPa (gage) 100 psig and Greater

Provide piping to and including the main steam pressure regulating valves, bypass valves, safety relief valves, and high pressure traps within each building under [Section 02554N, "Exterior Aboveground Steam Distribution"] [this section].

- a. Gate valves, globe valves, angle valves, and check valves: ASME B16.34, steel body, minimum of [ASME Class 150] [ASME Class 300]. Provide swing check valves.
- b. Steam pressure regulating valves: Steel body, minimum of ASME Class 150, except as modified herein. Valve seats and disc shall

be of replaceable heat-treated stainless steel. Valves shall be single seated; seat tight under dead end conditions, and move to the closed position in the event of pressure failure of the operating (controlling) medium. Provide strainer in inlet from external operating (controlling) medium. Valves shall be controlled by pilot valve with strainer at inlet from external pressure sensing piping. Valves shall be internally or externally steam traced for freeze protection. Valves shall be piston operated type or spring loaded diaphragm operated type with stainless steel springs.

- c. Safety-relief valves: Minimum of ASME Class 150, with test lever. Valves shall have steel or copper alloy body. Valves shall have flanged inlet and outlet connections or threaded connections attached to threaded ASME Class 150 flanges. Valves shall be ASME rated for capacity indicated.

## ]2.6 PIPING ACCESSORIES

### 2.6.1 Pipe Hangers and Supports

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

### 2.6.2 Strainers

Pressure and temperature range shall be for the intended service. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. Provide stainless steel strainer element with perforations of 1.194 mm 0.047 inch for water, 0.787 mm 0.031 inch for steam mixed with condensate, and 0.4064 mm 0.016 inch for steam. Provide copper alloy or cast-iron body strainers in steam and condensate systems up to 690 Kpa (gage) 100 psig. Provide steel body strainers in steam and condensate systems 690 kPa (gage) 100 psig and greater.

### 2.6.3 Traps

Provide traps of the types indicated with stainless steel internals. Pressure and temperature range shall be for the intended service. Traps for steam at 690 kPa 100 psig and greater shall be minimum of ASME Class 150.

### 2.6.4 Pressure Gages

Provide single style pressure gage with 115 mm 4.5 inch dial, brass or aluminum case, bronze tube, gage cock, pressure snubber, and syphon. Provide scale range for intended service.

### 2.6.5 Thermometers

Provide bi-metal dial type thermometers with stainless steel case, stem, and fixed thread connection; 80 mm 3 inch diameter dial with glass face

gasketed within the case; and accuracy within 2 percent of scale range. Provide scale range for intended service.

#### 2.6.6 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide 25 mm one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

##### 2.6.6.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or Schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

##### 2.6.6.2 Sleeves not in Masonry and Concrete

Provide 0.55 mm 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

#### 2.6.7 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid where indicated. Connectors shall be suitable for the intended service.

#### 2.6.8 Sight Glass and Refrigerant Drier

ARI 710. Provide in refrigerant liquid piping.

#### 2.6.9 Expansion Tanks

Construct of steel for minimum working pressure of 862 kPa (gage) 125 psig. Tank shall have polypropylene or butyl lined diaphragm which keeps the air charge separated from the water.

#### 2.6.10 Air Separators

[Provide tangential inlet and outlet connections, blowdown connections, and internal perforated stainless steel air collector tube to direct released air to automatic air vent. Construct of steel for minimum working pressure of 862 kPa (gage) 125 psig.] [Design to separate air from water and to direct released air to automatic air vent. Unit shall be of one piece cast-iron construction with internal baffles and two air chambers at top of unit; one air chamber shall have outlet to expansion tank and other air chamber shall be provided with automatic air release device. Unit shall be for minimum working pressure of 862 kPa (gage) 125 psig.]

#### 2.6.11 Flash Tanks

Construct of steel for minimum working pressure of 862 kPa (gage) 125 psig.  
Provide tank with vent and valved drain.

#### 2.6.12 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

#### 2.7 HEAT TAPE

Provide UL listed parallel conduction type heat tape and adjustable thermostat. The tape shall not be affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere.

#### 2.8 ACCESS DOORS FOR VALVES

Provide factory-prefabricated and primed flush face steel access doors including steel door frame for with continuous hinges and turn-screw-operated latch. Provide door frame installation in plaster and masonry walls. Furnish doors under this section; install doors under appropriate section of this specification.

#### 2.9 CHEMICAL FEED TANK

Construct of steel for minimum working pressure of 862 kPa (gage) 125 psig. Provide chemical pipe, fittings, and valves as specified for water piping. Add borate-nitrite corrosion inhibitors to initial fill water for heating and cooling water systems in concentrations of 0.0148 liters per liter one-half ounce per gallon of system water.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 HVAC EQUIPMENT

Installation of HVAC equipment including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with , ASME B31.5, ASME B31.9,NFPA 70, and in compliance with the manufacturer's written installation instructions, including the following:

- [(1) Packaged air-conditioners - installation instructions]
- [(2) Split-system air-conditioners - installation instructions]
- [(3) Packaged heat pumps - installation instructions]
- [(4) Split-system heat pumps - installation instructions]
- [(5) Packaged air-handling units - installation instructions]
- [(6) Multizone air-handling units - installation instructions]
- [(7) Air-cooled water chillers - installation instructions]
- [(8) Air-cooled condensing units - installation instructions]



- [(9) Room fan-coil air-conditioners - installation instructions]
- [(10) Room air-conditioners - installation instructions]
- [(11) Packaged terminal air-conditioners - installation instructions]
- [(12) Packaged terminal heat pumps - installation instructions]
- [(13) Series fan powered variable air volume (VAV) terminals - installation instructions; submit with respective air-handling unit.]
- [(14) Liquid cooling radiators - installation instructions]
- [(15) Unit heaters - installation instructions]
- [(16) Oil-fired heating boilers - installation instructions and underground fuel oil storage tank - installation instructions]
- [(17) Pumps - installation instructions]
- [(18) Exhaust fans - installation instructions]
- [(19) Direct vent gas-fired central furnaces - installation instructions]
- [(20) Fire dampers - installation instructions]

### 3.1.2 Connections to Existing Systems

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

### 3.2 PIPING

Installation of HVAC piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASME B31.5, and ASME B31.9. Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections. Make changes in piping sizes through tapered reducing fittings; bushings will not be permitted. Install valves with stems horizontal or above. Provide flanges or unions at valves, traps, strainers, and connections to equipment; unions are not required in copper tubing piping systems.

Threaded connections: Provide Teflon pipe thread paste on male threads. Do not thread metal pipe into plastic piping.

Pipe hangers and supports: Provide additional pipe hangers and supports at in-line water pumps and flanged valves.

Support plastic piping every 1.22 meters 4 feet. Support metal piping

as follows:

#### MAXIMUM SPACING (METERS)

Nominal Pipe Size (mm)	25 mm and under	31.4	38.1	50.8	63.5	76.2	88.9	102	127	152
Copper Tubing	1.83	2.13	2.44	2.44	2.74	3.05	3.35	3.66	3.96	4.27
Steel Pipe	2.13	2.44	2.74	3.05	3.35	3.66	3.76	4.27	4.88	5.18

#### MAXIMUM SPACING (FEET)

Nominal Pipe Size (inches)	One and under	1.25	1.5	2	2.5	3	3.5	4	5	6
Copper Tubing	6	7	8	8	9	10	11	12	13	14
Steel Pipe	7	8	9	10	11	12	13	14	16	17

Cleaning of piping: Keep interior and ends of new piping and existing piping affected by Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by Contractor's operations with new work of same construction.

Tee Joints: Extracted tee joints may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to ensure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

### 3.3 AIR DUCTS

Obtain approval before applying insulation.

### 3.4 ADJUSTMENTS

Adjust controls and equipment so as to give satisfactory operation. Adjust entire water temperature control system and place in operation so that water quantities circulated are as indicated. Air duct systems shall be adjusted and balanced so that air quantities at outlets are as indicated and so that distribution from supply outlets is free from drafts and has uniform velocity over the face of each outlet.

### 3.5 INSTRUCTING OPERATING PERSONNEL

Upon completion of work and at time designated by Contracting Officer, provide services of competent technician for period of not less than [\_\_\_\_\_] [one 8-hour] working day for instruction of Government operating personnel in proper operation and maintenance of equipment.

### 3.6 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each system in service to demonstrate compliance with the contract requirements. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided by Contractor and repeat tests. Furnish steam, fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, ducts, and filters.

#### 3.6.1 Piping Systems Except for Refrigerant Piping

Before insulating, hydrostatically test each new piping system at not less than 1297 kPa (gage) 188 psig; except pneumatically test fuel oil storage tank and fuel piping system at not less than 34.5 kPa (gage) 5 psig for tank and 345 kPa (gage) 50 psig for piping. Maintain pressure for 2 hours with no leakage or reduction in gage pressure. Obtain approval before applying insulation.

#### 3.6.2 Refrigerant Piping

Perform following when field piping connections are provided.

- a. Pressure test: Test refrigerant piping using dry, oil-free nitrogen, and prove tight at 2069 kPa (gage) 300 psig on the high side and 1034 kPa (gage) 150 psig on the low side. Maintain pressure for 2 hours with no leakage or reduction in gage pressure.
- b. Evacuation: Using high vacuum pump and certified micron gage, reduce absolute pressure on both sides of system simultaneously to 300 microns 300 microns. After reaching this point charge system with proper refrigerant until pressure of zero kPa (gage) psig is obtained. Repeat evacuation-charging procedure for two more cycles, totaling to three evacuation-charging cycles. On final evacuation, secure pump and maintain 300 microns 300 microns for 2 hours before charging with required final refrigerant.

#### 3.6.3 Equipment

##### 3.6.3.1 Field Acceptance Test Plans

- a. Manufacturer's Test Plans: Within [120] [\_\_\_\_\_] calendar days after contract award, submit the following plans:
  - [(1) Packaged air-conditioners - field acceptance test plan]
  - [(2) Split-system air-conditioners - field acceptance test plan]
  - [(3) Packaged heat pumps - field acceptance test plan]

- [(4) Split-system heat pumps - field acceptance test plan]
- [(5) Packaged air-handling units - field acceptance test plan]
- [(6) Multi-zone air-handling units - field acceptance test plan]
- [(7) Air-cooled water chillers - field acceptance test plan]
- [(8) Variable air volume (VAV) terminals - field acceptance test plan]
- [(9) Air-cooled condensing units - field acceptance test plan]

Field acceptance test plans shall developed by the equipment manufacturer detailing recommended field test procedures for that particular type and size of equipment. field acceptance test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment, will not be acceptable.

The Contracting Officer will review and approve the field acceptance test plan for each of the listed equipment prior to commencement of field testing of the equipment. The approved field acceptance test plans shall be the plan and procedures followed for the field acceptance tests of the equipment and test reporting.

- b. Coordinated testing: Indicate in each field acceptance test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of equipment controls which interlock and interface with controls factory prewired or external controls for the equipment provided under [Section 15901N, "Space Temperature Control Systems"] [Section 15910N, "Direct Digital Control Systems"].
- c. Prerequisite testing: Equipment for which performance testing is dependent upon the completion of the work covered by Section 15950N, "HVAC Testing/Adjusting/Balancing" must have that work completed as a prerequisite to testing work under this section. Indicate in each field acceptance test plan when such prerequisite work is required.
- d. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures shall be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

Controllers shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

- e. Performance variables: Each test plan shall list performance

variables that are required to be measured or tested as part of the field test.

Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Manufacturer shall furnish with each test procedure a description of acceptable results that have been verified.

Manufacturer shall identify the acceptable limits or tolerances within which each tested performance variable shall acceptably operate.

- f. Job specific: Each test plan shall be job specific and shall address the particular item of equipment and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.
- g. Specialized components: Each test plan shall include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

#### 3.6.3.2 Field Acceptance Testing

- a. Equipment Requiring Test Reports: Each piece of equipment listed shall be field acceptance tested in compliance with its approved field acceptance test plan and the resulting following field acceptance test report submitted for approval:
  - [1. Packaged air-conditioners - field acceptance test report; equipment greater than 52,700 W 180,000 Btuh.]
  - [2. Split-system air-conditioners - field acceptance test report; equipment greater than 52,700 W 180,000 Btuh.]
  - [3. Packaged heat pumps - field acceptance test report; equipment greater than 17,600 W 60,000 Btuh.]
  - [4. Split-system heat pumps - field acceptance test report; equipment greater than 17,600 W 60,000 Btuh.]
  - [5. Packaged air-handling units - field acceptance test report; equipment greater than 944 L/S 2,000 cfm.]
  - [6. Multi-zone air-handling units - field acceptance test report; equipment greater than 944 L/S 2,000 cfm.]
  - [7. Air-cooled water chillers - field acceptance test report; equipment greater than 52,700 W 180,000 Btuh.]
  - [8. Variable air volume (VAV) terminals - field acceptance test report; including plan for related air handling unit.]
  - [9. Air-cooled condensing units - field acceptance test report; equipment greater than 52,700 W 180,00 Btuh.]
- b. Manufacturer's recommended testing: Conduct the manufacturer's recommend field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution

of the field acceptance testing.

- c. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every two hours. Use the test report forms for logging the operational variables.
- d. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.
- e. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment shall be reviewed, approved, and signed by the Contractor's test director and the QC manager. The manufacturer's field test representative shall review, approve, and sign the report of the manufacturer's recommended test. Signatures shall be accompanied by the person's name typed.
- f. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

#### 3.6.3.3 Field Acceptance Testing of Minor HVAC Equipment

[For equipment not covered by test plans and test reports specified above, test][Test] each item of equipment in operation for continuous period of not less than 24 hours under every condition of operation in accordance with each equipment manufacturer's recommendation. Verify that the equipment operating parameters are within limits recommended by the manufacturer.

#### 3.6.4 Boiler

\*\*\*\*\*

**NOTE: Use the following paragraph in projects that provide new or repair existing boilers, or direct fired water heaters with an input capacity of less than 117 KW400,000 Btuh.**

\*\*\*\*\*

[Hydrostatically test at pressure of not less than 414 kPa (gage) 60 psig before being placed in operation. Notify Contracting Officer in writing when boiler is ready for testing and before boiler is operated.]

\*\*\*\*\*

**NOTE: Use the following paragraph in projects that provide new or repair existing boilers, or direct fired water heaters with an input capacity of 117 KW 400,000 Btuh or more. ITC of residential and commercial warm air furnaces or unit heaters is not required. NFGS-L-15991 covers requirements for Contractor furnished inspection, testing, and**

certification (ITC) of boilers, including portable  
boilers.

\*\*\*\*\*  
[Requirements for field testing, inspection, and certification of boilers  
is specified in the Section 15991N, "Inspection, Testing, and Certification  
of Boilers".]

\*\*\*\*\*  
NOTE: Next two paragraphs: Use Section 15950,  
"HVAC Testing/Adjusting/Balancing" for systems  
greater than 52,700 W 180,000 Btuh; use Section  
15949, "HVAC Testing/Adjusting/Balancing Small HVAC  
Systems" for systems less than 52,700 W 180,000 Btuh  
and greater than 28,100 W 96,000 Btuh.

Use the third paragraph for systems which have less  
than 28100 W 96,000 Btuh of cooling, or less than  
372 square meters 4000 square feet of floor space,  
or less than 15 supply air outlets.

\*\*\*\*\*  
[3.6.5 Related Field Testing

Requirements for testing, adjusting, and balancing (TAB) of ducts, piping,  
and equipment is specified in Section 15950N, "HVAC  
Testing/Adjusting/Balancing". Provide support personnel and equipment as  
specified in Section 15950, to assist TAB team to meet the TAB work  
requirements.

] [3.6.6 Related Field Testing For Small Systems

Requirements for testing, adjusting, and balancing (TAB) of ducts, piping,  
and equipment is specified in Section 15949N, "HVAC  
Testing/Adjusting/Balancing for Small HVAC Systems". Provide support  
personnel and equipment as specified in Section 15949, to assist TAB team  
to meet the TAB work requirements.

] [3.6.7 Testing and Balancing

Balance airflow in accordance with SMACNA HVACTAB and flows indicated.  
Submit written certificate to report the following:

- a. Air-handling unit and condensing unit nameplate data, and actual  
voltage and ampere consumption.
- b. Supply and return terminal airflow, and equipment used to measure  
airflow.
- c. Air-handling unit in and out cfm and temperatures.
- d. Ambient outside air temperature, date, and person testing,  
balancing, and reporting.

]

-- End of Section --